

**HOST PEST RELATIONSHIP OF THE GENUS, *HYPOTHENEMUS*
(SCOLYTIDAE: COLEOPTERA) WITH SPECIAL REFERENCE
TO THE COFFEE BERRY BORER, *H. HAMPEI*.**

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SUMMARY

The relationship between 46 of the most important mono-oligo - and poly-phagous species of *Hypothenemus* with their reported host plants belonging to 34 different plant families is critically reviewed.

The host preferences of *H. hampei* for different species of *Coffea* and varieties of *C. arabica* are discussed. It is suggested that the recorded alternate hosts of the coffee berry borer could only be alternate shelters for wandering of lost females, and not hosts on which the beetles could feed or grow.

INTRODUCTION

The genus, *Hypothenemus* is one of the least investigated of all the scolytid beetles, though it is known to comprise a large number of species which feed on bark and fruits of various economically important plants in the tropics, subtropics and temperate countries; information on its taxonomic characteristics is limited probably because it is one of the most difficult genera to classify (Wood 1980, personal communication). Bright (1972) has provided identification characters of the genus, based on (1) club-shaped antenna with first suture partly separate, (2) raised pronotum with lateral margin extended up to one third the distance from the basal margin, and (3) abundant vestitures with rows of setae on elytra.

Identification of *Hypothenemus* species is apparently more difficult, as is reflected by the fact that the generic or specific nomenclature of *H. hampei* which is economically the most important species of the genus, was changed fifteen times between 1867, when Ferrari first described it as *Cryphalus hampei*, and 1961 when Browne re-examined the species and confirmed it as *hampei* (Johanneson 1983, Johanneson et al 1984).

In spite of the fact that *H. hampei* has been studied for over a century, there appears to be no published account of the taxonomic characters of the species which could be used by field entomologists for quick and correct identifications. With such scarce and insufficient taxonomic literature, one wonders about the accuracy of the recorded species of *Hypothenemus* on one or more host plants.

The present article critically examines the recorded *Hypothenemus*-host relationship in a broader context of the general insect-host plant relationship, pointing out anomalies and needs for greater research.

HOST PLANTS OF *HYPOTHENEMUS*

General insect-host relationship

Kennedy (1953) defined a host plant as the "one that not only provides food but is lived on". Indeed such a broad-based definition is required for understanding the role of various plants on which less studied genera of insects such as *Hypothenemus* are found; some of these host plants may be used only as occasional or accidental shelters whereas, others are depended upon for the supply of food.

The relationship of various species of the genus *Hypothenemus* with their host plants appears to be very complex. Firstly, the morphology and biology of most of the species are closely allied to each other and pose great difficulty to the entomologists in their proper identification (Wood 1980 personal communication). Secondly, many of the host plants regarded as primary, secondary or alternate, may only be accidental shelters (Filho 1927). Any of these factors could change the entire understanding of the host-pest relationship for a particular species. For instance, *H. hampei* was earlier recorded as a polyphagous species but is now considered to be monophagous, having conditioned itself to a single host on which it has become almost entirely dependent (Browne 1961). Has the insect become specific in its nutritional requirements or was it a case of misidentification with species found on other hosts, or more likely the misinterpretation of the relative roles of various host plants from which the species was recorded?

Confusion is also created by the absence of any general agreement or convention among the entomologists on the definitions of the commonly used terms such as mono-, oligo-, or polyphagous insects. Monophagy is defined by Hill (1975) as a situation where an insect species restricts its feeding to a single plant species.

Smiley (1978) defined monophagous insects as those feeding or consuming only one species of host plant at the local population level, but Browne (1961) and Leftwich (1976) extended the definition to embrace different plant species belonging to the same genera. Oligophagous insects, as defined by Leftwich (1976) are those "with restricted range of food plants of related orders or even a single genus". Smiley (1978) however restricted the choice to "more than one species at the local population level". Polyphagous insects are considered to feed on "a range of hosts" (Hill 1975) or "many kinds of food" (Leftwich 1976). However, it does not seem to be quite clear whether the food plants should be enumerated by species, genera or families. Certainly an insect specific to a family such as Cruciferae has a rather extensive food plant range in the terms of number of plant species". Apparently this criticism is still valid.

Classifying the types of phytophagous insects on the basis of the presence of particular chemical attractants in a certain species, genus or family of plants poses even greater problems, since a lot of research on plant chemistry is required before any meaningful conclusion can be drawn. However, one has to study them because the problem of host preference in phytophagous insects is the heart of agricultural entomology (Lipke and Fraenkel 1956). Dethier (1947) has suggested that attraction to one chemical or to a group of chemicals, confused by the insect as one, could be called monophagy. For instance, an insect species which feeds specifically on a large number of Cruciferous and other plant families which contain mustard oil glucosides would be regarded as monophagous. However, the larvae of *Plutella maculipennis* (Curtis) feeds on plants which may or may not contain the glucosides (Thorsteinson 1960).

Oligophagy is defined in terms of attraction to several different chemicals. However, "the oligophagous habits in *Leptinotarsa decimlineata* (Say) larvae may not be based on a restricted distribution of feeding stimulants, as has been assumed, but on the absence of feeding inhibitors in the food plants and the presence of inhibitors in all other plants. "It is evident that the oligophagous food habit involves a variety of mechanisms which, when more fully understood will not comfortably fall into a single class" (Thorsteinson 1960). Polyphagy is also defined in terms of the presence of a variety of feeding stimulants or absence of feeding inhibitors in a wide range of plant types (Thorsteinson 1960).

Host Plants of *Hypothenemus*

In view of the possible discrepancies in the proper identification of different species of *Hypothenemus* and in the usage of the terms monophagous and polyphagous due to the aforementioned difficulties, it may be desirable to summarise the recorded information on the host plants of major species of the genus *Hypothenemus* before discussing the host of *H. hampei*. At least 316 species of plants, belonging to over 70 families, serve as a source of food or provide shelter to them. The available data on the number of hostplant species and families, along with the names of major plant families from which the 46 most important species of *Hypothenemus* were recovered are presented in Table 1. The terms mono-, oligo- and polyphagous have been used in the Table to categorize *Hypothenemus* species which feed or live on different genera of one family, or two or three families, or of many families of plants, respectively.

Thirteen species of *Hypothenemus* are monophagous, eight of which including *H. hampei* have been recorded from the *Coffea* species. At least eleven species of the genus may be considered oligophagous as they restrict their feeding to plants belonging to two or three families. Only eight species may be considered polyphagous, having been recorded from plants belonging to four to 46 different families e. g. *H. myristicae* Hopkins, *H. cameranus* Eggers, *H. uniseriatus* Eggers, *H. socialis* Schedl, *H. hispidus* Eggers, *H. grandis* Schedl, *H. pusillus* Eggers, *H. eruditus* Westwood. The feeding status of the remaining 14 species of *Hypothenemus* mentioned in Table 1 cannot be determined because of insufficient data about their host plants.

Members of the family Rubiaceae appear to be the most preferred host of *Hypothenemus*, as 18 species of the beetles were recorded from these plants. The other preferred host families are Caesalpinaceae, Sterculiaceae, Euphorbiaceae, Malvaceae, Rosaceae, Myristicaceae, from which eight, six, five, four and three different species of the beetles were recorded respectively.

Host Plants and varietal preferences of *H. hampei*

Members of the genus *Coffea* family Rubiaceae, which was first identified by Linnaeus in 1737 (Wellman 1961) is the primary, if not the only host plant of the coffee berry borer. Although the number of species belonging to the genus *Coffea* may vary from 60

Table 1. Major species of *Hypothenemus* recorded around the world and their host plants

No.	Species ^a	Distribution	Type of feeder	Recorded site	Host species	Plants families	Major host families ^b	References
1	<i>H. Hampel</i> Ferr.	Tropical Africa, South-East Asia, Central and South America Jamaica, Tahiti	mono- phagous	fruit	6	1	Ru, <i>Coffea</i> sp.	Browne (1961) Le Pelley (1968)
2	<i>H. seriatus</i> (Eichhoff)	Brazil	mono- phagous	fruit (pulp)	?	1	Ru, <i>Coffea</i> sp.	Le Pelley (1968) Filho (1927)
3	<i>H. opacus</i> (Eichhoff)	Brazil	mono- phagous	berries	?	1	Ru, <i>Coffea</i> sp.	Le Pelley (1968)
4	<i>H. flavosquenosus</i> Hopkins	West Africa (Liberia)	mono- phagous	?	?	1	Ru, <i>Coffea</i> sp.	Schedl (1961)
5	<i>H. pallidus</i> Hopkins	Liberia	mono- phagous	fruit, twig	?	1	Ru, <i>Coffea</i> sp.	Schedl (1961)
6	<i>H. cylindripennis</i> Schedl.	Belgian Congo.	mono- phagous	?	1	1	Ru, <i>Pentas</i> sp.	Schedl (1961)
7	<i>H. hystrix</i> Eggers	Amani	mono- phagous	?	1	1	Lau, <i>Laurus</i> <i>nobilis</i>	Schedl (1961)

No	Species ^a	Distribution	Type of feeder	Recorded site	Host species	plants families	Major host families ^b	References
8	<i>H. fuscicollis</i> (Eichhoff)	Brazil	mono-phagous	seed	?	1	Ru, <i>Coffea</i> sp.	Le Pelley (1968)
9	<i>H. buscki</i> (Hopkins)	Columbia	mono-phagous	seed	?	1	Ru, <i>Coffea</i> sp.	Le Pelley (1968)
10	<i>H. mali</i>	South Africa	mono-phagous	fruit	1	1	Ro.	Schedl (1961)
11	<i>H. punctipennis</i> Hopkins	South Africa	mono-phagous	twig	?	1	Ro.	Schedl (1961)
12	<i>H. parcius</i> Schedl.	Belgian Congo.	mono-phagous	twig	?	1	Sa.	Schedl (1961)
13	<i>H. cyanometree</i> Schedl.	Belgian Congo.	mono-phagous	?	1	1	Ca.	Schedl (1961)
14	<i>H. glabratus</i> Schedl.	Malaya	oligo-phagous	twigs	3	2	D, Ur.	Browne (1961)
15	<i>H. striatulus</i> Schedl.	Malaya, Java, Fiji	oligo-phagous	twig	?	2	St, Le.	Browne (1961)

15	<i>H. striatulus</i> Schedl.	Malaya, Java, Fiji	oligo- phagous	twig	?	2	St, Le.	Browne (1961)
16	<i>H. sundaensis</i> Eggers	Malaya, Sumatra, Java, Borneo	oligo- phagous	?	3	2	Pa, Bi.	Browne (1961)
17	<i>H. bauhiniæ</i> Schedl.	Belgian Congo, Sierra Leone	oligo- phagous	twig	2	2	Ca, Eu	Schedl (1961)
18	<i>H. bassavaensis</i> Schedl.	Madagascar, Uganda, Belgian Congo	oligo- phagous	twig	?	2	Eu, Pu.	Schedl (1961)
19	<i>H. aulmanni</i> Hagedorn	Central Africa, Ceylon, Tanzania	oligo- phagous	twig	?	2	Ru, St	Le Pelley (1968)
20	<i>H. glabratellus</i> Schedl	Malaya, Jamaica	oligo- phagous	twig, leaf litter	?	>1	D.	Bright (1972) Schedl (1961)
21	<i>H. areccæ</i> Horn	Brazil, Malaya, Java, Sumatra, India, Congo	oligo- phagous	twig, nut berries	7	2	D, Ru	Browne (1961) Le Pelley (1968)
22	<i>H. plumeriæ</i> Noerdlinger	Brazil, Surinam	oligo- phagous	beans berries	?	>1	Ru, <i>coffea</i> sp.	Le Pelley (1968)
23	<i>H. obscurus</i> Fabricius	Southern and East America, Mexico, Brazil, Central America, Jamaica, Ivory Coast	oligo- phagous	seeds of trees	?	>1	Ru.	Le Pelley (1968)

No.	Species ^a	Distribution	Type of Recorded feeder	Recorded site	Host species	plants families	Major host families ^b	References
24	<i>H. georgiae</i> Hopkins	Southern U. S. A., Jamaica, New Caledonia	oligo- phagous	fruit	?	>1	My.	Bright (1972)
25	<i>H. eruditus</i> Westwood	Tropical Africa, Central and South America, U.S.S.R., Japan, Java, Philippines, West Indies	poly- phagous	bark, twig, fruit, grains	113	46	An, Ap, D, El, Eu, Ca, Pa, Pap, Browne (1961) Pi, Ma, Me, My, Schedl (1961) Myr, Mi, Ro, Rut, Ru, St, Ti, Ur, Ve.	Bright (1972) Eu, Ca, Pa, Pap, Browne (1961) Pi, Ma, Me, My, Schedl (1961) Myr, Mi, Ro, Rut, Ru, St, Ti, Ur, Ve.
26	<i>H. pusillus</i> Eggers	Belgain Congo, Ivory Coast, Sierra Leone, Madagascar	poly- phagous	twig	58	27	Ca, Eu, St, Ru, Ma, My, Ro.	(Schedl 1961)
27	<i>H. grandis</i> (Schedl)	Tanzania, Belgian Congo	poly- phagous	twig	17	14	Co, Eu, La, Ma, Pap, Ru, St, Ti, Ro.	Schedl (1961)
28	<i>H. hispidus</i> Eggers	Burma, Malaya, Philippines, Ivory Coast, Sierra Leone	poly- phagous	twig, fruit	16	12	Bo, Ca, D, Gr, Ga, Ma, Mo, My, Ru.	Browne (1961) Schedl (1961)
29	<i>H. socialis</i> Schedl	Congo, Angola, Ghana	poly- phagous	seeds	?	5	Ca, Mi, Pap, Ul, St.	Le Pelley (1968)

29	<i>H. socialis</i> Schedl	Congo, Angola, Ghana	poly- phagous	seeds	?	5	Ca, Mi, Pap, U, St.	Le Pelley (1968)
30	<i>H. univertatus</i> (Eggers)	Tropical Africa, Ceylon, Jamaica	Poly- phagous	twig, seed	?	5	Ca, Ru.	Bright (1972) Schedl (1961)
31	<i>H. cameranus</i> Eggers	Ghana, Camerouns, Congo, Angola, Tanzania	poly- phagous	bark	?	5	Ca, Mi, Pap, U ¹ , St.	Schedl (1961)
32	<i>H. myristicae</i> Hopkins	Malaya, Java	poly- phagous	twig	?	4	My, Pi, Ti, D.	Browne (1961)
33	<i>H. bambesanus</i> Eggers	Belgain Congo	?	?	?	?	?	Schedl (1961)
34	<i>H. erythrinae</i> Eggers	India, Fiji, Malaya	?	?	?	?	?	Browne (1961)
35	<i>H. bolivanus</i> Eggers	Bolivia, Brazil, Costa Rica, Jamaica	?	?	?	?	?	Bright (1972)
36	<i>H. brunneus</i> Hopkins	Southern U. S. A., West Indies, West Africa	?	seed	?	?	Mangrove	Bright (1972)
37	<i>H. birmanus</i> Eichhoff	Southern U. S. A., West Indies, West Africa	?	?	?	?	?	Bright (1972) Browne (1961)
38	<i>H. comosus</i> Bright	Jamaica	?	?	?	?	?	Bright (1972)
39	<i>H. elephes</i> Eichhoff	Mozambique, Madagascar, Belgain Congo	?	?	?	?	?	Schedl (1961)
40	<i>H. lineatus</i> Eggers	Belgain Congo, Tanzania	?	?	?	?	Mu.	Schedl (1961)

No. Species ^a	Distribution	Type of feeder	Recorded site	Host species	plants families	Major host families ^b	References
41 <i>H. polyphagus</i> Egge, s	Sierra Leone, Uganda, Tropical Africa	?	twig, fruit, seed	?	> 1	Ru, <i>Coffea</i> sp.	Schedl (1961)
42 <i>H. minor</i> Eggers	East Africa	?	?	?	?	?	Schedl (1961)
43 <i>H. mosehatae</i> Schauf	Jamaica	?	fruit	?	1	L. (<i>Tamarindus indica</i>)	Bright (1972)
44 <i>H. mozambiquensis</i> Eggers	Mozambique, Zambesi, Sierra Leone	?	?	?	> 1	Ca. (<i>Bauhinia</i> sp.)	Schedl (1961)
45 <i>H. sambesianus</i> Eggers	Zambesi	?	?	?	?	?	Schedl (1961)
46 <i>H. setosus</i> Eichhope	Guadeloupe, Jamaica	?	?	?	?	?	Bright (1972)

a. *H. javauus*, *H. interstitialis*, *H. crudiae* have also been recorded as being present in Jamaica (Wood 1980, personal communication) but their hosts have not been recorded.

b.

An, Annonaceae.,	Ap, Apocynaceae.,	Ni, Bixaceae.,	Bo, Bombaceae.,	Ca, Caesalpiniaceae.,
Co, Compositae.,	D, Dipterocarpaceae ,	El, Elaeocarpaceae ,	Eu, Euphorbiaceae.,	Gr, Graminae.,
Gu, Guttiferae.,	L, Leguminosae ,	Lab, Labiatae.,	Lau, Lauraceae.,	Ma, Malvaceae,
Me, Meliaceae ,	Mi, Mimosaceae.,	Mo, Moraceae.,	Mu, Musaceae,	My, Myristicaceae ,
Myr, Myrtaceae.,	Pa, Palmae.,	Pap, Papilionaceae.,	Pi, Pinaceae,	Pu, Punicaceae.,
Ro, Rosaceae ,	Ru, Rubiaceae.,	Rut, Rutaceae.,	Sa, Sapotaceae,	St, Sterculiaceae.,
T, Tiliaceae.,	Ul, Ulmaceae.,	Ur, Urticaceae.,	Ve, Verbenaceae.,	

Table 2. Host and 'alternate' host plants of *H. hampei*

Status	Plant family	Genus and species	Reference
HOST	Rubiaceae	<i>Coffea arabica</i>	2
		<i>C. canephora</i>	2
		<i>C. dewevrei</i>	2
		<i>C. dybowskii</i>	
		<i>C. excelsa</i>	5
		<i>C. liberica</i>	5
		<i>C. abeokutae</i>	5
		<i>C. quilouensis</i>	10
		<i>C. arnoldiana</i>	10CC
		<i>C. congensis</i>	10
		<i>C. aruwimiensis</i>	10
		<i>C. stenophylla</i>	10
'ALTERNATE'	Rubiaceae	<i>Oxyanthus</i> sp.	8
	Leguminosae	<i>Dialium lacourtina</i>	6
	Caesalpinia- ceae	<i>Caesalpinia</i> sp.	7
	Papilliona- ceae	<i>Crotolaria</i> sp.	1
		<i>Tephrosia</i> sp.	1
		<i>Centrosema</i> sp.	11
		<i>Phaseolus lunatus</i>	7
	Mimosaceae	<i>Acacia decurrens</i>	3
		<i>Leucaena glauca</i>	6
	Malvaceae	<i>Hibiscus</i> sp.	9
		<i>Abelmoschus</i> sp.	4
		<i>Gossypium</i> sp.	4
	Euphorbia- ceae	<i>Ricinus communis</i>	4
	Graminae	<i>Zea</i> sp.	4
	Rosaceae	<i>Rubus</i> sp.	8
	Oleaceae	<i>Liqustrum pubinerva</i>	8
	Vitaceae	<i>Vitis lancelaria</i>	8

1. Begeman (1926); 2. Chevalier (1947); 3. D'Angremond (1940)
 4. Filho (1927); 5. Friederichs (1914); 6. Ghesquiere (1927);
 7. Hargreaves (1926), 8. Leefmanns (1923), 9. Mayne (1914);
 10. Ticheler (1961); 11. Ultee (1926).

My, Myristicaceae,
 Pu, Punicaceae.,
 St, Sterculiaceae.,
 Mu, Musaceae,
 Pi, Pinaceae.,
 Sa, Sapotaceae,
 Ve, Verbenaceae.,
 Mo, Moraceae.,
 Pap, Papilionaceae.,
 Rut, Rutaceae.,
 Ur, Urticaceae.,
 Mi, Mimosaceae.,
 Pa, Palmae.,
 Ru, Rubiaceae.,
 Ul, Ulmaceae.,
 Me, Meliaceae,
 Myr, Myrtaceae.,
 Ro, Rosaceae,
 T, Tiliaceae.,

(Chevalier 1947, Coste 1955) to 100 (Cramer 1957), *H. hampei* has been recorded from only six of them, namely *C. arabica*, *C. canephora*, *C. dewevrei*, *C. dybowskii*, *C. excelsa* and *C. liberica*, in order of preference (Lepelley 1968, (Table 2).

Filho (1927) did not find any preference by *H. hampei* for *C. arabica*, *C. canephora*, *C. excelsa* or *C. liberica*, or among the common, yellow, sumatra, bourbon, maragogype and murta varieties of *C. arabica*. Koch (1873) also could not find any preference by the borer for different species of *Coffea*.

Ticheler (1961), however, observed the preferential boring by *H. hampei*, into different species and varieties of coffee in the Ivory Coast which was in the following order: *C. quilouensis*, *C. quilouensis* var. quillon, *C. quilouensis* var. uganda, *C. canephora*, *C. aranoldiana*, *C. congensis*, *C. robusta*, *C. liberica* x *C. arabica*, *C. liberica* x *C. laurentii*, *C. aruwimiensis*, *C. excelsa*, *C. abeokutae*, *C. stenophylla* and *C. dybowski*.

In laboratory studies, Boothe and Mansingh (Unpublished) did not find any preferential infestation by *H. hampei* in *C. arabica* var. *caturra*, *typica* or *geisha*, though fecundity of adults and survival of immature stages were significantly greater in *caturra* than in *typica*, and at least 30% less in *geisha* berries. These physiological parameters were correlated with differences in protein, carbohydrate and lipid contents of the berries of the three varieties.

H. hampei has been recorded from the fruits of plants belonging to 16 genera of 10 different plant families other than species of *Coffea*; it was also found under the bark of *Accacia decurrens* (Table 2). Although these plants have been termed alternate hosts (Filho 1927, Ticheler 1961, Lepelley 1968) their role as host plant for the borer is debatable, since only adult females were ever found in these 'hosts'. In our experience, the borer is quite precise in its dietary requirements and will not feed or develop on any host which is not suitable. However, it may enter an alternate shelter such as okra and tamarind to avoid desiccation. In fact the female adults of *H. hampei* inherently enters into a reproductive diapause soon after maturation and mating; this is terminated only after the beetle starts to feed, usually after migration to new suitable *Coffea* hosts (unpublished). Indeed Filho (1927) had failed to observe any egg laying by the borer in the berries of *C. schumaniana* which obviously was nutritionally unsuitable but provided refuge against environmental adversities to an otherwise lost female.

It may be concluded that unless data on the biology of different species of *Hypothenemus* on the recorded host plants is obtained, the real status of many hosts and alternath hosts will remain doubtful. For economically important species, the host-pest relationship should be clearly established for basing effective management strategies.

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